tion of the eyes to the right, the side of the lesion, than in deviation toward the left. In a case of cerebellar abscess that I saw in consultation with Dr. B. A. Randall the nystagmus was much greater when the eyes were turned toward the side of the lesion than when they were turned away from it. I have not been able to make this observation in any other case, but I speak of it in the hope that it may prove to be of clinical value.

Oppenheim describes involuntary movements, tremor, occurring in cases of cerebellar tumor, and such movements were present in Case V.

A DISCUSSION OF THE SURGERY OF TUMORS OF THE BRAIN, WITH A RESUME OF THE OPERATIVE RECORDS OF FOUR CRANIOTOMIES.

By Charles H. Frazier, M.D.,
PROFESSOR OF SURGERY, UNIVERSITY OF PENNSYLVANIA; SURGEON TO THE UNIVERSITY HOSPITAL.

The statistics of the last five years give us every reason to take a more hopeful view of the surgery of cerebral tumors. It will be admitted without question that the greater attainments of more recent years are to be attributed to an earlier recognition of the tumor, to a correspondingly earlier resort to operation, to more accurate localization, and, finally, to certain distinct improvements in the technique. The latter may be said to include a speedier method of opening the skull, the exposure of a much larger area of the brain than was possible before the introduction of the osteoplastic flap, the adoption of the two-stage operation in those cases in which the blood pressure is materially depressed by the preliminary procedures. Many of the improvements or modifications of the technique in operations upon the brain have in view a common object, the prevention of shock. Operating as we are upon such a highly sensitive organ as the brain, and upon the organ which presides over functions so essential to the maintenance of life, additional precautions must be taken. The precautions which one ordinarily takes to prevent shock in operations upon other organs must be observed in brain operations the more stringently; the avoidance of unnecessary exposure, the avoidance of unnecessarily prolonged operation, the prevention of excessive hemorrhage, the avoidance of unnecessarily rough manipulations of the tissue, the administration of the anæsthetic by an experienced man; careful observation of the patient's condition, more particularly of the circulatory function, throughout the operation at frequent intervals; these are all points to which the greatest importance should be attached.

METHOD OF MAKING THE OSTEOPLASTIC OR WAGNER FLAP. The instrument which in our experience at the University Hospital seems to meet every indication is the so-called dental engine armed with a trephine and drill. Given an area of brain to expose, an osteoplastic flap of corresponding size can be made with much less traumatism and in a much shorter time with this instrument than with any other. Objections to other instruments may readily be found. In fashioning the flap with chisel and mallet a degree of traumatism must be inflicted upon the nervous structures within the skull, which is, to say the least, undesirable, and in the opinion of some surgeons the hammering increases the shock, and thereby adds to the risk of the operation. As compared with any of the other methods this is by all odds the crudest. The Gigli saw may be used, but a good deal of time is consumed in making the necessary number of trephine openings, and passage of the saw from one opening to another is neither an easy nor, in all cases, a safe procedure. The Stellwagen trephine, which was placed on the market a little over a year ago, is an ingenious instrument, but, from the mechanical point of view, is not to be compared with the dental engine. The efficacy of the Stellwagen trephine depends upon the ability to fix the central plate —this can only be accomplished by screwing the plate to the skull; but even after the central plate has been secured in place it requires a good deal of practice and force to be able to saw through the entire thickness of the skull in a reasonably short time. But there is still another and what I consider a very serious objection to this instrument, namely, the loss of a considerable amount of blood before the flap is reflected and the hemorrhage controllable. The greatest amount of bleeding comes from the venous channels in the diploë; with the Stellwagen trephine one begins to saw through the skull layer by layer from without inward until one reaches the diploë; upon reaching the inner table of the skull, one must proceed more slowly and with greater caution, because of the danger of penetrating the dura and injuring the brain. Meanwhile, hemorrhage from the diploic vessels is very free, and, of course, uncontrollable until the bone is entirely divided and the flap reflected. The drill of the dental engine divides the entire thickness of bone as it proceeds; furthermore, it seems to crush and occlude the openings of the diploic sinuses, and in that way spontaneously controls hemorrhage. Including the series of cases recorded in this paper, I have performed in the last six months some ten craniotomies with the dental engine, and I believe that with this instrument a given area of the brain can be exposed with the minimum degree of traumatism and in the minimum amount of time. The element of time plays a most important part in the outcome of operations for brain tumor. Mills,[1] in a paper presented to the College of Physicians in 1902, said: "I am satisfied that the present dangers to life in operations for brain tumor are from hemorrhage and prolonged operation." Therefore, the addition to our armamentarium of an instrument which economizes time will tend toward lowering the mortality. In the absence of complications it is quite possible without undue haste to completely divide and reflect the bony flap in eight minutes. It requires but very little practice to become proficient in the use of this instrument. After the incision has been made in the scalp, corresponding to the size and shape of the flap, an opening in the skull at one extremity of the incision is made with a small trephine operated by the engine. This will consume but a fraction of a minute. A small dural separator is inserted in the opening in order to make sure that the dura is free from the bone before the bone-drill is introduced. This can be attached to the engine without any risk of the operator's hand coming in contact with any portion of the engine that may not be sterile. The drill is now introduced and the bone divided from one extremity of the incision to the other. To guard against the possibility of the wound becoming infected from particles of dust that may be cast off from the arm or pulleys of the electric motor, an assistant plays a stream of sterile water or normal salt solution over the field of operation while the machine is in motion. But two objections to this method of performing craniotomies suggest themselves: one, the possibility of infection; the other, the possibility of dividing the dura and lacerating the brain substance should the dura be adherent.

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[1] Philadelphia Medical Journal, September 27, 1902.

I have already referred to the manner in which infection may be guarded against. The danger of dividing the dura and lacerating the brain substance in those cases in which the dura is adherent is not incurred by this method more than by any other. No matter what the instrument selected for dividing the bone, if the dura be firmly adherent to the skull it will be exposed to the possibility of laceration. One of the advantages of making the flap of liberal dimensions is that there will be a margin of normal tissue between the lesion and the edges of the osseous opening. The possibility of the line of the bone-flap traversing the affected area is more remote.

McCosh, of New York, makes use of the electric engine in his craniotomies. A small bulb of the shape of a pear, about one-quarter of an inch in diameter, is attached to the engine, and with this bulb four or five holes are bored through the skull; the cone shape of the bulb allows the point to penetrate through the skull as it is revolved, and yet prevents the shaft from entering the skull or penetrating the dura. When the holes have been made the bulb is removed, and there is substituted a small circular saw, and the bone between the holes made by the burr sawed through. A small projecting and protecting flange is screwed to the side of the circular saw, so that the blade of the saw is exposed only for the depth of the skull as measured through the holes, and in this way the danger of sawing through the dura is wholly obviated.[1] This instrument would, it seems to me, require much more practice in order to enable one to operate it with safety. If one depends, in the adjustment of the flange, upon the depth of the skull measured at any one of the holes the danger of sawing through the dura cannot, as it is claimed, be wholly obviated. The depth or thickness of the skull varies, so that there would always be the possibility of the saw penetrating the dura if the skull were thicker at one of the holes than elsewhere, or what is also an objection, though not such a serious one, the saw would not penetrate the entire thickness of the skull if the skull were thinner at the point measured than it was at some other point along the projected incision.

CONTROL OF HEMORRHAGE. Exceptional precautions should be adopted to control hemorrhage from the very outstart. The amount of blood which will be lost from an extensive incision of the scalp might be considerable. The loss of blood will be reduced to a minimum by the application of a tourniquet around the head. I have been in the habit of using for this purpose rubber tubing. Dr. Cushing showed me recently an appliance for this purpose which seemed to me very superior. It consists of an inflatable tube, which fits snugly the head of the patient, and with a small bicycle pump can be distended sufficiently to exert the necessary degree of pressure. If no tourniquet is used, it is a good plan to make the incision section by section, stopping to control the hemorrhage from one section before proceeding to the next. Hemorrhage from the diploic sinuses is satisfactorily controlled by Horsley's wax. When we come to the question of the control of hemorrhage from the brain and tumor itself, we are confronted with a more difficult problem. But two courses are open: one to pack gauze firmly into the wound, the other to close one or both carotids temporarily. The latter course would seem to be the ideal course were the practice of it unattended with risk. Crile, to whom we are indebted for this suggestion, performed this preliminary operation in a series of cases without any serious after-effects. It seemed to me that, if as in Crile's hands this operation were free from danger, a very important contribution had been made to the technique of brain surgery. My personal experience, however, has not confirmed these views. In the first place, temporary closure of the carotids does not altogether control hemorrhage; it controls arterial hemorrhage, but upon the venous hemorrhage, which is the much more troublesome, it has little effect. But in addition to the control being ineffectual, it is not unattended by risk, at least it has not been in my hands. I have practised temporary closure of the carotid but five times in all, including two of the cases in this report, and from this limited experience I am firmly of the opinion that Crile's method should be reserved for the extreme cases, and in these should be confined to one side.

The posture of the patient during the operation should, of course, not be overlooked. Hemorrhage will be less free if the patient's head and body are well elevated. Unless the patient is in a state of shock I am in the habit of continuing elevation of the head and shoulders after the patient is transferred from the operating-table to his bed.

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[1] Starr. Journal of Nervous and Mental Disease, July, 1903.

Observations upon the Blood Pressure. One of the signs of increased intracranial tension of whatever origin is elevation of the blood pressure. It is present in depressed fractures of the skull, in intracranial hemorrhage, in cerebral contusion and concussion, as well as in brain tumor. In a very exhaustive work on concussion and cerebral compression by Kocher and his students, the effects of intracranial tension upon the circulation of the brain were studied. It was observed that when the compression was of a very moderate degree there developed primarily a venous stasis or disdiamyrrhosis. This was due to the obstruction of the venous circulation by the increased intracranial pressure. If this pressure continues or increases the circulation of the brain becomes re-established; this phenomenon is attributed to a stimulation of the vasomotor centre, which, acting through the peripheral vessels, causes such an increase in the arterial pressure as will compensate for the increased cranial tension. And so it is that in the presence of a brain tumor we often find the blood pressure elevated above normal. In all operations for the removal of brain tumors I have made it a practice to make an observation of the blood pressure before the operation and to have the observations upon the blood pressure continued throughout the operation. These observations are recorded on a chart designed for this especial purpose; on it are recorded by an assistant a tracing of the pulse and blood pressure in such a way that the operator can see at a glance what the pulse rate and degree of blood pressure may be. The sphygmograph,[1] which is used in my clinic, is very simple in its construction, and can be operated without any difficulty by an untrained assistant.

The object in having this record made throughout the operation is twofold. In the first place, generally speaking, the condition of the blood pressure is the most reliable index of the patient's condition; when the normal blood pressure is sustained throughout the operation we are assured that the operative procedures have not been of sufficient gravity to induce shock. This applies, of course, to operative procedures generally, and is not confined to those upon the brain; but in operations for the removal of tumors of the brain the blood pressure index is of much greater significance, in that it assists us in determining whether the operation should be performed in one or two stages.

Indications for Two-stage Operation. It has been said that 25 per cent. would be considered a conservative estimate of patients who died immediately from the effects of operation. In some cases death is attributed to shock, in some to concussion, and in some to

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[1] It is a modification of the Riva-Rocci instrument that was worked out by Dr. Stanton, Instructor in Medicine at the University of Pennsylvania.

"unknown causes." In a discussion on the subject of brain tumors at the October meeting of the College of Physicians I said that I was inclined to believe that in the latter class of cases death was due to the sudden withdrawal of intracranial pressure. In the investigations of Kocher, that have already been referred to, it was demonstrated that the sudden withdrawal of intracranial pressure, after the blood pressure had been forced to a considerable height, may be followed by paralysis or break down of the vasomotor mechanism. If we are correct in assuming that this theory will explain many of the fatal terminations in a given number of cases, we should give more serious consideration to the advisability of dividing the operation into two stages. Horsley recommends the adoption of this procedure in every case without exception, and v. Bergmann, though not going so far as Horsley, recommended the two-stage operation in cases in which the patient's general condition was below par, or in which the tumor was a particularly large one. Horsley's recommendation seems to me unnecessarily radical, and that of v. Bergmann too indefinite. It seems to me a rule may be formulated which is based upon a much more scientific basis, namely, that when after the relief of pressure, such as would follow the removal of the osteoplastic flap and the reflection of the dura, there is a very decided fall in the blood pressure, an attempt should not be made at that sitting to remove the tumor. The completion of the operation should be postponed until the circulatory equilibrium has been restored, that is, until the circulation of the brain has become adjusted to the newly instituted physical conditions. This may mean the delay of a week or a delay of but forty-eight hours. [In order to determine in more exact terms the effect of the sudden removal from the brain of such pressure as would be exerted by a tumor, I am conducting a series of experiments upon dogs, in which an inflated rubber bag is introduced beneath the dura and distended so gradually as to simulate the growth of a tumor; when the bag is distended to a considerable size the fluid will be withdrawn suddenly, and the effect of the collapse of the bag upon the blood pressure will be recorded.]

In Case III. of this series such a course was adopted. The patient had a large subcortical tumor. Soon after the dural flap was reflected there was such a fall of blood pressure that I decided to postpone for the time being further operative intervention. The patient soon recovered from the effects of the preliminary step, but I feel quite sure that if I had continued with the operation and attempted to remove the tumor the circulatory disturbance would have been aggravated, and the patient would have died. In Case II. it will be noted in the chart that after the completion of the first stage of the operation the patient was not suffering from depression of the circulation. Accordingly, I proceeded and removed the tumor. The tumor proved to be a small one, so small that its presence had not caused enough increased tension to disturb the circulation, and the removal was effected, therefore, without affecting the blood pressure.

Sommer[1] reports his experience in an operation for sarcoma of the brain. Death ensued a few hours afterward for no demonstrable reason. The author says that in this as in many other cases death is due to sudden change in the circulation. His views coincide with mine. As a means of relieving pressure he recommends lumbar puncture in addition to the reflection of the osteoplastic flap as a preliminary measure, postponing for a few days any attempt to remove the growth. Lumbar puncture would no doubt relieve pressure temporarily, but whether its effects would be enduring enough to be of any practical value I am not prepared to say. Furthermore, lumbar puncture is in itself a dangerous procedure, and especially so in brain tumors. A number of sudden deaths have been reported as having been caused by this procedure.

AS TO THE QUESTION OF BULGING OF THE BRAIN. If the most alarming feature of brain operation is hemorrhage, the most troublesome is the bulging of the brain that follows reflection of the dura. In the course of our operations Dr. Spiller and I have made certain observations bearing upon this subject. As a preface to these observations it should be stated that a distinction is made between the bulging which occurs immediately after the dura is reflected, which will for convenience sake be termed "initial" bulging, and that which manifests itself during the subsequent exploratory manœuvres, or "consecutive" bulging.

First, when a tumor is present there may be little or no initial bulging, but there is not likely to be any consecutive bulging. By this we mean that, given a case in which the tumor has been localized accurately and occupies the field bounded by the opening in the skull, there may be little or no bulging, even though the tumor be one of very considerable dimensions. In Cases II. and III. of this report there were present a small and a very large tumor respectively, and yet in neither case was there any initial or consecutive bulging. No doubt the character of the tumor would have some effect—thus a very vascular sarcoma would be more likely to bulge through the opening than a gumma. The release of pressure from a growth abounding in large vascular channels would result in a reactionary dilatation, more particularly of the venous channels, and this in turn might be followed by such circulatory disturbances as would readily lead to cerebral œdema. What we want to call particular attention to is this: that in the absence of bulging one must not be led to believe that there can be no tumor present.

Secondly, that when the tumor was not found, and if present was not situated at or beneath the area exposed, "consecutive" bulging was a very conspicuous feature, and the degree of bulging far exceeded the initial bulging observed when tumors were present. This at first thought seems as it were paradoxical, but upon further consideration is readily explained. It is due to the fact that normal brain tissue being the more sensitive reacts more rapidly to the insult of traumatism. When the looked-for lesion does not present itself on the surface of the brain at the site of exposure certain exploratory measures are instituted: the brain is palpated to determine its consistency, exploratory incisions are made into the cortex to determine whether the growth is subcortical, and the exploratory needle is introduced in the search for deep-seated collections of fluid. Meantime the brain surface is subjected to the injurious influence of a comparatively low temperature. Each one of these exploratory measures inflicts a traumatism of greater or less degree, and, as a result of their combined effects, the brain swells with amazing rapidity, so that within a few moments it protrudes so beyond the dura that it becomes a physical impossibility to replace it sufficiently to unite the edges of the dural wound. The actual cause of the swelling is no doubt the development of œdema. As pointed out by Cannon, who conducted a series of experiments in order to explain the secondary increase of intracranial pressure in head injuries, the swelling and pressure are wholly independent of any increase of blood pressure whatever, and are the result of certain chemical changes in the brain substance itself, whereby the osmotic pressure is so increased that the brain rapidly becomes œdematous.

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[1] Beiträge zur Psychiatrie klinik, 1902, vol. i. p. 5.

The practical lessons to be learned from these observations are easily foreseen. In the first place, have we not in this rapid and consecutive œdema a sign that the tissue presenting in the opening is chiefly normal brain tissue, and that if there be a tumor present in the region exposed it is in all likelihood a very small one? Secondly, these observations should teach us the importance of carrying out the exploratory measures in an expeditious manner. To be sure, we should not proceed with undue haste, but once the dura is exposed the various methods of exploration should be carried out in a methodical and unhesitating manner. A definite plan of procedure should be outlined before the operation begins, the instruments for exploration should be at hand, and once the dura is reflected the operator should, without a moment's delay, proceed with his investigation, and in the following order: 1. A careful inspection of the exposed cortex, noting whether pulsation is visible, whether the brain is of normal color, and noting the condition of the bloodvessels. Inspection should precede all the other forms of examination because soon after exposure of the brain to the traumatism inflicted by the examining finger the brain begins to bulge. The operator should palpate, gently of course, the cortex, both the part exposed and, if nothing abnormal be found there, the parts immediately surrounding. By palpation one can discover variations in consistency and in tension. V. Bergmann recommends in those cases in which the tumor cannot be felt that the patient be raised to a sitting posture, "whereupon the tumor may become visible or palpable, the area exposed sinking in somewhat from the atmospheric pressure in connection with the lessened blood pressure."[1] 2. If by palpation one discovers an increase in the consistency, and inspection fails to reveal a growth involving the cortex, an incision of from 1 to 3 cm. should be made in the direction of the suspected lesion. The importance of making more than a nick in the surface of the brain needs no explanation. In Case III., although the tumor would not have been removed at the first operation, it was not discovered, simply because the incision was not deep enough to expose it. 3. Failing to reveal the lesion, an exploratory needle, constructed especially for this purpose, should be introduced in two or three directions, but always through the same opening. The instrument best adapted to this purpose is a small cannula armed with a blunt obturator. The instrument should be introduced to the maximum depth, the obturator removed, and the instrument gradually withdrawn. The ordinary exploratory needle is useless, because upon its introduction the orifice becomes plugged with cerebral tissue, and the communication between a cyst or an abscess is thereby cut off.

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[1] Woolsey. THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES, December, 1903.

Given a case in which the brain has bulged to a very considerable degree, how should this complication be treated? Three courses are open to the operator: the first to attempt to restore the brain to its normal confines and to close the dural wound; the second, to disregard absolutely the dura and to terminate the operation by closing the wound in the scalp; and the third, to make no attempt to replace the brain, but to repair the defect between the dural edges with a graft dissected from the pericranium. The adoption of one or the other of these three courses should depend upon existing conditions.

For purposes of illustration, imagine a case in which the tumor has not been found and in which there is an element of uncertainty in the diagnosis as to the existence of tumor. Under these conditions, if the dural edges cannot be approximated without such pressure upon the bulging brain as would lead inevitably to an undesirable amount of laceration of the brain substance, such a plan as that suggested by Keen should be carried out, namely, to dissect from the pericranium a graft large enough to fill the gap between the edges of the dura. This plan was adopted in Case IV. of this series. A diagnosis of tumor of the brain had been made, but instead of a tumor a tubercular meningitis almost confined to the parietal lobe was found. Shortly after the dura was reflected and the field explored the brain began to bulge in an amazingly and alarmingly rapid manner; to have attempted to suture the dura without removing a large section of the brain would have been a physical impossibility, and, inasmuch as there was no indication for the relief of pressure, the gap in the wound was closed in the manner as above described. As illustrating another phase of the question, picture a case in which a tumor was undoubtedly present, but had been localized inaccurately —a case in which headache was one of the conspicuous and most distressing symptoms. A radical operation in such a case is, for the time being at least, out of the question; but we have every reason to believe that in relieving pressure the patient will enjoy a temporary period of relief. If, then, the indication is clearly to relieve pressure, it would be the height of folly to attempt to sew up the dura, as by so doing the intracranial pressure would be as great as it was before the operation. Under these circumstances the dura should be disregarded absolutely, the bone of the flap should be removed, and the wound in the scalp closed with great precision.

PALLIATIVE OPERATION. In every operator's experience there will be a certain number of cases which for one reason or another are not suitable for the radical operation, either because the tumor is inaccessible, or because it may be too large, or because accurate localization is impossible. Under any of these circumstances when the patient is suffering, evidently from the effects of increased intracranial tension—*e. g.*, headache, or choked disk—the palliative operation should be performed. I say "should be" because I believe an operation under these circumstances is more than a question of propriety; it should be regarded as imperative. Were it not for the headache the patient might enjoy for the rest of his days freedom from pain, if pressure is relieved. I have under my care now a patient that was referred to me by Dr. Hermance and Dr. Spiller, a patient who has unquestionably a tumor, but no symptoms sufficiently pronounced to make localization possible. He suffered from attacks of such violent headache that his reason became impaired; his suffering was intense and only to be compared with that attending the paroxysms of tic douloureux. Opiates did not relieve him. A section of bone was removed from the skull, and with but two exceptions, when the attacks were not severe and of very short duration, he has enjoyed absolute relief from pain, and is as contented and placid as one could be under the circumstances. The same gratifying effects may be obtained in cases of choked disk. When this condition has not existed so long as to have caused atrophy of the optic nerve an early operation for the relief of pressure will be followed by marked subsidence of or disappearance of the choked disk and by a corresponding improvement of vision. We are thus enabled to restore to a greater or less degree the patient's vision for the remainder of his life. In a case recently operated upon the effect of craniotomy and consequent relief of pressure was very strikingly illustrated. The choked disk, which was present to a very marked degree, subsided at least one-half within three weeks of the date of the operation. Unfortunately in this case the operation was not performed soon enough to save the patient's vision, as very marked atrophy of the optic nerve had already occurred. For the relief of these two conditions, namely, headache and impairment of vision, I lay stress upon the importance of the palliative operation. In performing this operation a section of bone representing about three square inches should be removed and a dural flap fashioned and reflected, and the wound in the scalp closed. This will afford the desired relief of tension.

RESULTS. As to the more recent statistics upon the results of surgical intervention for cerebral tumor, Woolsey[1] has collected 101 cases of cerebral tumors which have been operated upon during the past five years. Of this series he says: "Twelve cases, 11.8 per cent., died within twenty-four hours, and twenty-six, or 25.7 per cent., within three weeks." Here at once we see a very marked reduction in the immediate mortality. Von Bergmann regards 25 per cent. as a very conservative estimate of the number dying as the direct result of the operation. Of the eighty-eight cases of Woolsey's series, of which an exact localization was made, the mortality was but 22.7 per cent., as against 46 per cent. among those not exactly localized. In Gussenbauer's series of twelve cases there was but one death, and that due to pneumonia. "As to the more remote results, six died within three weeks and three months; nine between three months and one year, and three between one year and two years. As almost all of these died from the effect of the tumor the mortality within two years is 43.5 per cent." This high mortality, both immediate and remote, Woolsey says is not greater than that following radical operations for malignant growths in some other situations, and that considering "the otherwise hopeless condition of these cases, the difficulties of exact diagnosis, the inaccessibility of the tumors, and the marked relief of symptoms in almost all cases not dying at once, we may take courage and feel some degree of satisfaction." Woolsey says "that we should feel still more encouraged when we consider the length of time during which some cases remain free of recurrences. Cases of sarcoma are reported four years, four years and one month, five and one-half years, and eleven years after operation. A case of fibroma was reported well eight years, cases of gummata two and one-half years, a case of glioma three and one-half years, and one case, in which the variety of tumor was not given, nine years after the operation. Seven cases of sarcomata are reported to have recurred at periods ranging from three months to eleven years, and averaging two years and four months, or, exclusive of the latter case, nine and one-third months."

It is needless to say that the prognosis in the case of benign tumors and cysts and in cases of well-encapsulated sarcomata is much better than in operations when the growths are of malignant and infiltrating type.

RESUME. 1. All measures recognized as prophylactic of shock should be observed stringently. In these we have the most effectual means of reducing the mortality. The most important of them are (*a*) the avoidance of prolonged operation; (*b*) the prevention of excessive hemorrhage, and (*c*) the avoidance of unnecessarily rough manipulation of the brain substance.

2. A given area of brain can be exposed with the least minimum degree of traumatism and greatest economy of time by the electric engine.

3. Temporary closure of the carotids in operations upon the brain is ineffectual and not unattended by danger. It should be reserved for extreme cases, and practised on one side only.

4. Observations should be made upon the blood pressure immediately before and at frequent intervals during the operation. Object of same twofold: (*a*) as the most reliable index of patient's condition; (*b*) as the only exact method of determining whether operation should or should not be carried out in two stages.

5. Two-stage operation is indicated when there has been a decided fall in blood pressure after the relief from intracranial tension, such as follows reflection of the Wagner flap and dura.

6. Lumbar puncture as a means of relieving pressure is a temporary, not to say dangerous, procedure.

7. Bulging of the brain is one of the most embarrassing features of cerebral operations. A distinction may be made between that which occurs immediately after reflecting the dura, "initial" bulging, and that which follows as a result of subsequent exploratory manipulation, "consecutive" bulging.

8. "Initial" bulging is due to the increased tension exerted by a tumor. It is not always present, is often not excessive, and is not likely to be followed by "consecutive" bulging.

9. "Consecutive" bulging is due to the cerebral œdema set up in normal brain tissue by trauma inflicted by the exploratory manipulations. "Consecutive" bulging far exceeds in magnitude initial bulging, and suggests the absence of a tumor of considerable size at the seat of operation.

10. In order to avoid this "consecutive" bulging, which is a most embarrassing feature of these operations, exploration should be carried out in the most expeditious manner.

11. When the edges of the dural wound cannot be approximated without undue tension or without great laceration of brain substance, the gap should be closed by a graft taken from the pericranium, providing the tumor has not been found and there is reason to question the accuracy of the diagnosis.

12. When there is every assurance of a tumor being present, but it proves to be inoperable or was imperfectly localized, no attempt should be made to close the dura, as in so doing the best possible palliative effects of the operation would be counteracted.

13. Palliative operations should be regarded not merely as operations of propriety, but should be considered imperative whenever the tumor cannot be found or cannot be removed.

14. A statistical study of the results of the last five years is encouraging. The mortality, both immediate and subsequent, has been reduced materially. Recurrence after operations for malignant growths of the brain is no greater than after operations for malignant growth of other structures.

Resume of the Operative Records.[1]

Case II.—*G. K.; operation May* 2, 1903; *osteoplastic resection of the skull; exposure and removal of cortical sarcoma; recovery from immediate effects of operation; marked improvement in patient's condition during a period of several weeks; return of the growth, with fatal termination.*

Upon reflection of the osteoplastic flap and dura an area was exposed to view which, to the touch and sight, was unquestionably pathological, and proved to be the tumor. Before proceeding to remove the tumor, consideration was taken of the patient's condition, and more particularly of his circulation. If from the effect of the preliminary procedures the patient's circulation had been depressed, further manipulation would have been postponed for twenty-four to forty-eight hours, or until the circulation was re-established. In the absence of any alarming evidence of depression, the operation was continued and the tumor removed. There were no technical difficulties nor hemorrhage attending this step of the operation.

The tumor was not situated in the centre of the area which was exposed, but quite near the margin of the opening, so that if the opening in the skull had been a small one it is quite possible that the tumor might have escaped the eye of the operator.

At the end of the operation the patient's temperature was 96° F., his pulse 92, and his respirations 28. The patient reacted quite promptly, and at no time did we entertain doubt as to his recovery from the immediate effects of the operation. On the evening of the operation there was complete paralysis of the right arm and leg, and aphasia; but the following morning the function of both limbs was partially restored and the patient could speak, but very indistinctly. On the fifth day a very decided improvement was observed, both in the size of his vocabulary and in the rapidity with which he could give expression to his thoughts. Generally speaking, there was a decided improvement over his condition before the operation. The headache of which he had complained so bitterly was almost entirely relieved. Occasionally he complained of a soreness in his head, but the constant distressing headache so characteristic of brain tumor had disappeared. Two weeks after the operation he left his bed, and would have been discharged from the hospital had it not been thought desirable to keep him under observation for a longer period.

Case III.—*Thomas S., aged forty-seven years; operation June* 5, 1903; *osteoplastic resection of the skull; subcortical tumor below the surface of the brain within the white matter; not found because of its deep situation within the substance of the brain; operative recovery; death thirty-four days after the operation.*

After preliminary closure of the carotids the osteoplastic flap and its dura were reflected and the brain exposed. When the dura was divided the brain did not protrude, as it so often does. Its surface was inspected and several gross lesions were noted in the field exposed. These lesions were quite superficial and were not sufficiently intense to explain the symptoms. Several incisions were made into the cortex of the brain about a centimetre in depth, with a view toward exposing a subcortical growth, but the incisions were not deep enough to have revealed the tumor which was discovered at the autopsy. The flaps were replaced and the wound closed. In this, as in the former case, the patient reacted promptly from the operation, and after a slight febrile reaction, running over a period of eight days, the temperature returned to normal. During the convalescent period the patient had some convulsions, Jacksonian in type, and his left upper limb became almost completely paralyzed. He was, however, almost entirely relieved of the headache from which he had been suffering. He was transferred to Dr. Spiller's ward three weeks after the operation.

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[1] Editorial Note.—The clinical histories of these cases appear in full in the article by Dr. Spiller in this number of the Journal.

CASE IV.—*F. F.; operation June* 23, 1903; *osteoplastic resection of the skull; exposure of multiple tubercular tumors* (*meningitis en plaque*) *of the parietal lobe; removal of growths impossible.*

Several observations upon the blood pressure were made prior to the operation, and, as is now my practice, these observations were continued at intervals of not less than five minutes throughout the operation. Anticipatory of hemorrhage, both common carotids were closed temporarily. A horseshoe-shaped flap composed of the scalp was fashioned with the knife of the Stellwagen instrument and the bony flap with the drill and dental engine. Upon attempting to reflect the dura numerous adhesions were discovered between it and the cortex, but these were separated without much difficulty. Upon reflection of the dura numerous lesions, some isolated, some confluent, were revealed distributed over the entire area of the cortex which had been exposed to view. Upon introducing my index finger between the dura and exploring the cortex in all directions, I discovered more adhesions. The discovery of the latter was sufficient to warrant the assumption that the process was too diffuse and of such a nature as to render it positively inoperable. Although the manipulations had up to this time been neither prolonged nor of such a character as to inflict serious traumatism upon the cerebral tissue, yet the brain had bulged to such an extent that it became quite evident that I would not be able to bring the edges of the dura into apposition. In order to guard against the development of a hernia or a fungus cerebri, a section of pericranium was removed of a size sufficient to fill in the gap in the dural wound. Within a few minutes of the time the brain was exposed, although nothing more than a careful inspection and exploration with the finger had been resorted to, the circulation began to fail, becoming more and more depressed until the termination of the operation, when the pulse was weak and the blood pressure alarmingly low (75). His condition for the first forty-eight hours was critical, but in the third day improved to such an extent that I began to feel more hopeful of his recovery from the operation. This reaction was only temporary, however, as œdema of the lungs rapidly developed, and on the fourth day after the operation the patient died.

CASE V.—*W. C. H.; tumor of right cerebellar lobe at its union with the pons; operation July* 23, 1903; *craniotomy of the cerebellar fossa; second stage of operation (opening of dura and exploration for tumor) postponed because of patient's serious condition.*

Realizing the difficulty with which all the surfaces of the cerebellum are exposed through a small unilateral opening and anticipating very free hemorrhage, not only from the scalp but from the diploic sinuses, I decided before the operation to secure a better opportunity to examine the suspected hemisphere by making a very liberal opening in the skull, one extending from one side to the other, and to control at least some of the hemorrhage by preliminary but temporary closure of the carotids. Proceeding along these lines, after the Crile clamps had been applied to the carotids I fashioned a horseshoe-shaped flap by making an incision from one mastoid process to another parallel to and 1 cm. above the superior curved line. After clamping the bleeding points in the flap, an opening in the skull was made with chisel and mallet 2 cm. below and 2 cm. from the median line. This opening was enlarged with the rongeur forceps equally in all directions until it extended above to the superior curved line and almost to the median line. A similar opening was made in the opposite side. By means of a Gigli saw the intervening bridge of bone was divided above and below and removed. With this the first stage of the operation was completed. The patient's condition at this time was such as to make it unwise to proceed to search for the tumor. From the beginning of the operation there was some evidence of impairment of the respiratory or circulatory function, perhaps both. This may or may not have been due to the anæsthesia (ether), to the loss of blood, to the fact that the position of the patient may have embarrassed respiration. At all events, he was more or less cyanosed throughout, and when the first stage of the operation was completed his pulse was very rapid (170 to 180), although his blood pressure was high (158). Immediately after his recovery from ether it was noted that he was hemiplegic. During the night his respirations were of the Cheyne-Stokes type, and there were some twitchings of the left side of the face. On the following morning, at 9 o'clock, his pulse reached its lowest rate (120), but from that time on until the patient's death, thirteen hours later, the pulse and temperature began to rise. The last registration was: pulse, 180; respiration, 24; temperature, 103.8° F.; blood pressure, 90.